COOLING MECHANISM FOR REFRIGERATION SYSTEMS

FIELD OF THE INVENTION

[0001] The present invention relates generally to refrigeration systems. More particularly, the present invention relates to a cooling mechanism for refrigeration systems.

BACKGROUND OF THE INVENTION

[0002] Refrigeration systems are important to many industries, in particular the grocery and food industry. Many such systems include a cooled display area in which products, such as meats, poultry, etc., can be displayed while kept at a cool temperature to prevent premature spoilage.

[0003] Most refrigeration systems include one or more evaporators, each having a single evaporator coil. Those coils are advantageously defrosted in order to prevent wear of the coils and prevent the product from getting too cold. Defrosting typically takes place three or four times daily, often in off-peak time to the extent it is possible, in order not to disrupt temperature during shopping hours.

[0004] There are currently three main defrosting methods for refrigerated display cases. The first method involves unassisted off-time evaporation/ventilation, where the compressor driving the evaporator coil is simply turned off for a period of time and the defrosting is achieved by exposure to the ambient temperature. The second method uses hot gas-assisted evaporation, where a hot gas is circulated in the evaporator coil during the defrost cycle in order to accelerate the defrosting process. The third method uses electric defrosting, which is similar to the hot-gas-assisted arrangement, but uses electricity to heat the evaporator coils and promote defrosting. The first method is slow, while the second and third methods, although faster, require extra energy to effect the defrosting.

[0005] After a defrosting cycle, the cooling system in the refrigerated display case has to re-cool the air in the display case, so that the products can be re-cooled and kept fresh. The refrigerated display case is typically kept at a temperature of about 2 degrees Celsius during a cooling cycle. The temperature of a display case during a defrost cycle can reach up to 13 degrees Celsius. Because of that, after defrosting the cooling system has to work hard to achieve its previous cooled temperature. The system has to overcome not only

the increase in the ambient air temperature, but also heating that has occurred in the product being cooled.

[0006] For meats, spoilage is a particular problem for grocery operators and other vendors. Most financial losses in meat departments are due to spoilage of meat caused in large part by defrost cycles, and not because of lack of sales. Since there is a high profit margin in meat sales, it is important that the quality of product be maintained. In addition to spoilage, meats are also subject to shrinkage due to the large proportion of water they contain. With conventional defrost cycles and their attended large temperature swings, meats can lose a large amount of their size and weight, resulting in lost sales for the seller since the meat has to be re-weighed and repackaged, if it can be salvaged at all.

[0007] Cooling systems are known in which a plurality of evaporators are provided in a refrigerated display case, and are divided into groups for cooling different sections of the refrigerated display case. The evaporators each have a single evaporator coil. The evaporators are provided in sections laterally adjacent one another and are defrosted, in their groups, in alternating staggered cycles. This is done in an attempt to mitigate some of the drawbacks of defrost cycles as discussed above. However, during any given defrost cycle according to such known systems having evaporator groups, the section being defrosted is still subjected to a significantly higher temperature than the cooled temperature, thereby increasing the possibility of spoiling the product in that section. Also, each section typically has a separate air return system, so that a given section remains hot during its defrost cycle, despite the fact that the surrounding sections are being cooled. Moreover, separate evaporators and compressors must be used in each section, which results in high energy consumption.

[0008] It is, therefore, desirable to provide a cooling mechanism for refrigeration systems that can more efficiently cool and defrost evaporator coils without large temperature swings.

SUMMARY OF THE INVENTION

[0009] It is an object of the present invention to obviate or mitigate at least one disadvantage of previous cooling mechanisms for refrigeration systems.

[0010] In a first aspect, the present invention provides an evaporator for use in a refrigerated display case having a display length. The evaporator includes first and second independent evaporator coils co-extensive along the display length, each evaporator coil operable in a cooling cycle and a defrost cycle in alternating time periods in such a manner as to maintain a substantially constant cooling temperature throughout the refrigerated display case, even during a defrost cycle.

[0011] In an embodiment, the evaporator further includes first and second independent sets of cooling fins mounted to the first and second evaporator coils, respectively, for absorbing heat when a refrigerant is circulated and evaporates in the evaporator coils, thus cooling the display case. In another embodiment, the evaporator further includes an insulating member, which can be made of a plastic, provided between the first and second independent evaporator coils, for minimizing effects of a change in temperature from a defrosting evaporator coil on a non-defrosting evaporator coil. Each evaporator coil can include an inlet end for receiving at least one feed of refrigerant from an independently controlled distributor line. Each evaporator coil can include an outlet end for returning gas refrigerant to a return for subsequent condensation and recirculation to the evaporator coil from which it originated.

[0012] In a further aspect, there is provided a cooling system for use in a refrigerated display case having a display length. The cooling system includes an evaporator having first and second independent evaporator coils co-extensive along the display length, each evaporator coil operable in a cooling cycle and a defrost cycle in alternating time periods in such a manner as to maintain a substantially constant cooling temperature throughout the refrigerated display case, even during a defrost cycle. The cooling system also includes a common return connected to the first and second evaporator coils for receiving ambientair to be cooled by the evaporator.

[0013] In an embodiment, the cooling system further includes first and second flow control valves, in communication with the first and second independent evaporator coils, respectively, for independently controlling refrigerant flow to the first and second independent evaporator coils. The cooling system can also include first and second filters, in communication with the first and second independent evaporator coils, respectively, for independently preventing impurities from entering into the first and second independent

evaporator coils. The cooling system can include first and second shutoff valves, in communication with the first and second independent evaporator coils, respectively, for manually stopping refrigerant flow to the first and second independent evaporator coils. The cooling system can also include first and second flow regulating devices, in communication with the first and second independent evaporator coils, respectively, for regulating refrigerant flow to the first and second independent evaporator coils. The cooling system can further include first and second distributors, in communication with the first and second independent evaporator coils, respectively, for equally distributing refrigerant flow to the first and second independent evaporator coils. A controller can also be provided in the cooling system, for scheduling and controlling the alternating defrost cycles of the first and second independent evaporator coils.

[0014] In a yet further aspect, there is provided a defrosting method for a refrigerated display case having first and second independent evaporator coils, the evaporator coils being co-extensive along a display length of the refrigerated display case. The method includes the following steps: cooling the first and second independent evaporator coils together; defrosting the first independent evaporator coil while cooling the second independent evaporator coil, the second independent evaporator coil substantially covering the entire length of a display case of the refrigeration system; cooling the first and second independent evaporator coils together; and defrosting the second independent evaporator coil while cooling the first independent evaporator coil, the first independent evaporator coil substantially covering the entire length of a display case of the refrigeration system.

[0015] In a still further aspect, there is provided a cooling system for use in a plurality of refrigerated display cases each having a display length. The cooling system includes a plurality of evaporators connected in parallel. Each evaporator has first and second independent evaporator coils co-extensive along the display length, with each evaporator coil being operable in a cooling cycle and a defrost cycle in alternating time periods in such a manner as to maintain a substantially constant cooling temperature throughout the refrigerated display case, even during a defrost cycle. The first evaporator coils of each of the plurality of evaporators are connected to one another and define a set of first evaporator coils. The second evaporator coils of each of the plurality of evaporators are connected to one another and define a set of second evaporator coils. First and second flow control

valves are provided, in communication with the sets of first and second evaporator coils, respectively, for independently controlling refrigerant flow to the sets of first and second sets of evaporator coils.

[0016] Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Embodiments of the present invention will now be described, by way of example only, with reference to the attached figures, wherein:

Figs. 1A and 1B are perspective views of conventional refrigerated display cases;

Figs. 2A, 2B and 2C are side, top and end views, respectively, of a conventional evaporator for use in a refrigerated display case;

Fig. 3 is a side view of a known configuration of evaporators for use in a refrigerated display case;

Figs. 4A, 4B and 4C are side, top and end views, respectively, of an evaporator according to an embodiment of the present invention for use in a refrigerated display case;

Fig. 5 is a top view of an evaporator according to another embodiment of the present invention for use in a refrigerated display case; and

Fig. 6 is an evaporator according to an embodiment of the present invention shown connected to a portion of a refrigeration system for use in a refrigerated display case.

DETAILED DESCRIPTION

[0018] Generally, the present invention provides an evaporator having first and second independent evaporator coils. The evaporator is for use in a refrigerated display case, either open or closed, having a display length. Each of the evaporator coils is co-extensive along the display length. The evaporator coils are alternately defrosted and cooled

in such a manner as to maintain a substantially constant cooling temperature throughout the refrigerated display case, even during a defrost cycle. An independent set of cooling fins is mounted to each of the evaporator coils for absorbing heat when a refrigerant, either liquid or gas, is circulated and evaporates in the evaporator coils, thus cooling the display case. A separate return is provided for each separate evaporator coil, though the two returns preferably join into a common return, thereby facilitating maintenance of a substantially constant cooling temperature.

[0019] The present invention preferably provides at least one of the following advantages over known systems: energy savings; time savings; better use of energy resources; increased product quality and product life; less water and vapour on display cases caused by changing temperature due to defrost cycles, resulting in a more pleasant shopping experience; and money savings due to decreased spoilage, meat re-packaging, and time spent rewrapping due to presence of blood in package from defrosting cycles.

[0020] **Fig. 1A** is a perspective view of a conventional refrigerated display case. The refrigerated display case **100** in **Fig. 1A** has a display case containing a display area having a single display shelf **102**. The display case **100** is shown with a near set of end pieces removed in order to better show some of the constituent parts thereof. An evaporator**104** is located underneath the display area to provide cooling to the display shelf **102**. The evaporator **104** is also connected to a series of inflow and outflow tubes, as well as to a ventilator, in order to circulate refrigerants through the evaporator and expel heated air by way of a return.

[0021] **Fig. 1B** is a perspective view of another conventional refrigerated display case. **Fig. 1B** illustrates the fact that a refrigerated display case **106** can have a plurality of display shelves **102** in its display area. This advantageously makes better use of floor space, for example, in a grocery store than a display case with a single display shelf. It also allows for the display of similar types of product in the same physical area and provides a retailer with opportunities to cross-sell different types of product to a customer.

[0022] **Figs. 2A**, **2B** and **2C** are side, top and end views, respectively, of a conventional evaporator **108** for use in a refrigerated display case. In **Fig. 2A**, the side view shows cooling fins **110**. The fins **110** are mounted to an evaporator coil. The evaporator coil **112** is a cooling coil, typically comprised of metal tubing in a snake-like configuration within

the evaporator **108** in order to maximize the surface area available for cooling ambient air. The evaporator coil is essentially a network of cooling tubes connected together as a single coil in the evaporator. The fins **110** are for absorbing heat when a refrigerant is circulated and evaporates in the evaporator coil, thus cooling the display case. The refrigerant can be a liquid or a gas. The evaporator **108** typically includes a plurality of brackets **114** to which the evaporator coil and the fins are mounted, in order to provide structural integrity to the evaporator.

[0023] The top view of **Fig. 2B** shows a portion of the evaporator coil **112**. **Fig. 2B** also shows a series of outlet tubes **116** that feed a single return **118**. The return **118** takes heated air (resulting from circulation of the refrigerant) and returns it to other portions of the cooling system to be cooled again by the refrigerant. **Fig. 2C** shows a plurality of rounded ends of a snaking evaporator coil. **Fig. 2C** also shows at the top thereof inlets for receiving a refrigerant, such as a liquid refrigerant, by means of a refrigerant line **120**. Although only one refrigerant line **120** is shown, for the sake of simplicity of illustration, there is typically a refrigerant line **120** connected to each inlet. At the bottom of **Fig. 2C** are shown outlet ends for feeding a return **118** or suction line.

[0024] **Fig. 3** is a side view of a known configuration of evaporators for use in a refrigerated display case. In **Fig. 3**, the evaporators are identical. However, the evaporators are provided and controlled in defrost groups. Evaporators **122** are in a first defrost group, and evaporators **124** and **126** are in a second and third defrost groups, respectively. Evaporators are provided laterally adjacent one another and are defrosted in groups in alternating staggered cycles, so that evaporators immediately adjacent one another are not simultaneously defrosted. For example, the first defrost group is defrosted, then the second defrost group, then the third.

[0025] However, during any given defrost cycle, the sections being defrosted are still subjected to a significantly higher temperature than the cooled temperature, thereby increasing the possibility of spoiling the product in that section. Also, each section has a separate air return system, so that a given section remains hot during its defrost cycle, despite the fact that the surrounding sections are being cooled.

[0026] **Figs. 4A**, **4B** and **4C** are side, top and end views, respectively, of an evaporator **128** according to an embodiment of the present invention for use in a refrigerated

display case. In **Fig. 4A**, the side view is generally similar to that of **Fig. 2A**. However, the evaporator **128** according to an embodiment of the present invention includes first and second independent evaporator coils, **130** and **132** co-extensive along the display length, i.e. each substantially covering an entire length of the display counter. Each of the independent evaporator coils **130** and **132** is operable in a cooling cycle and a defrost cycle in alternating time periods in such a manner as to maintain a substantially constant cooling temperature throughout the display case of the refrigeration system, even during a defrost cycle. The evaporator coils 130 and 132 are independently-controlled, as will be described later. Only the evaporator coil **130** is visible in **Fig. 4A** since the evaporator coil **132** is lined up directly behind the evaporator coil **130**. Each evaporator coil comprises a plurality of interconnected evaporator coil tubes. Such an evaporator coil is also known as a multi-circuit evaporator coil. Each tube is preferably made of a copper-aluminum composite material. The use of copper prevents the fins from moving during cooling and defrosting cycles, as opposed to simply using aluminum alone. The aluminum is used in the composite since it is thin and easy to work with.

[0027] In a particular example of the invention that was implemented, each evaporator coil **130** and **132** includes 24 tubes of copper pipe, for a total of 48 tubes in the evaporator. In known systems, 48 tubes were provided in the evaporator, but all being controlled as a single unit. In some known systems, as discussed earlier, different evaporators were provided in adjacent groups, which were each separately controlled. However, that separate control did not eliminate the fact that when one of the groups of evaporators was being defrosted, the product in the section being defrosted underwent significant warming.

[0028] Each of the first and second evaporator coils, **130** and **132**, has at least one inlet end **134** and **136**, respectively. Each inlet end **134** and **136** is for receiving at least one feed of refrigerant from an independently controlled distributor line. The refrigerant can be any suitable liquid or gas refrigerant, such as freon or glycol. Each of the first and second independent evaporator coils comprises an outlet end **138** and **140**, respectively, such as returns or suction lines. Each outlet end **138** and **140** is for returning gas refrigerant to a return for subsequent condensation and recirculation to the evaporator coil from which it originated. These inlet and outlet ends will be further described in relation to **Fig. 6**

[0029] When using an evaporator **128** according to an embodiment of the present invention, air circulates along the entire length of the display case through a common return, which is fed by outlets **138** and **140**. In known systems, each separate cooling section has its own return that doesn't mix with the other air. So, if a section is defrosted in the known systems, the ambient cooling air increases dramatically in temperature. According to embodiments of the present invention, because the return is common along the entire length of the display case, the cooling temperature can more easily be maintained.

[0030] In **Fig. 4B**, the independent nature and separation of the two evaporator coils **130** and **132** is readily apparent. Essentially, embodiments of the present invention provide the equivalent of two independent evaporators in the same physical casing. The evaporator **128** also includes first and second independent sets of cooling fins **142** and **144** mounted to the first and second evaporator coils **130** and **132**, respectively. Each set of cooling fins **142** and **144** is for absorbing heat when a refrigerant is circulated and evaporates in the evaporator coil, thus cooling the display case. Once again, at the right hand side of the figure are shown the two separate sets of evaporator coils **130** and **132**. At the left hand side are shown two separate sets of inflow lines. In **Fig. 4C**, the independent nature of the two evaporator coils **130** and **132** is illustrated, highlighted by the gap in between the two coils, which is in contrast to **Fig. 2C**, where the evaporator has one long interconnected coil.

[0031] **Fig. 5** is a top view of an evaporator according to another embodiment of the present invention for use in a refrigerated display case. Since **Fig. 5** is very similar to **Fig. 4B**, the common features will not be discussed. In the particular embodiment of **Fig. 5**, the evaporator **128** can include an insulating member **146** for isolating the first and second evaporator coils **130** and **132** from each other. The insulating member **146** can be, for example, made of a plastic, steel, or any other suitable material that can be used to isolate the two evaporator coils from each other, and prevent changes in one coil from having an effect on the other coil. The insulating member **146** can be placed between the two evaporator coils, as illustrated in **Fig. 5**. The insulating member is provided as an insulator in order to minimize the effects of the change in temperature from a defrosting evaporator coil on a non-defrosting evaporator coil. The insulating member can also minimize the risk of moisture dropping from a defrosting evaporator coil to a non-defrosting evaporator coil. Although the insulating member **146** is shown in **Fig. 5** as covering the entire length of the

evaporator **128**, this is only a preferred embodiment. Sufficient isolation, or insulation, can be provided with the insulating member **146** only covering a portion of the length of the evaporator.

[0032] **Fig. 6** illustrates a cooling system including an evaporator according to an embodiment of the present invention shown connected to a portion of a refrigeration system for use in a refrigerated display case. In **Fig. 6** the evaporator **128** receives an input from two separate feedings networks. The first evaporator coil **130** receives an input at inlet **134** from a refrigerant line controlled by a flow control valve, such as a solenoid valve, or solenoid, **146**. The second evaporator coil **132** receives an input at inlet **136** from a refrigerant line controlled by another solenoid valve **148**. Each flow control valve, or solenoid valve, in this arrangement acts mainly as a flow control device to control the flow of refrigerant in a refrigerant line, primarily to prevent flow into the evaporator during the defrost cycle, or off-cycle. Essentially, the first and second flow control valves are in communication with the first and second independent evaporator coils, respectively, for independently controlling refrigerant flow to the first and second independent evaporator coils. Solenoid valves are available for different applications and specifications, such as from the Sporlan Valve Company of Washington, Missouri.

[0033] In between the refrigerant line inflow end and each of the solenoid valves **146** and **148**, a filter **150** can optionally be provided. The filter **150**, typically a copper filter with some sort of microscopic grill, is provided to prevent impurities from entering into the evaporator. These impurities can be inherent from the evaporator coil piping itself, or may have been introduced at the time of installation. The filter **150** can therefore be considered almost as a type of insurance against improper installation. Most of the impurities can generally be filtered out in the first few hours or days of operation, but the filter **150** can be advantageously kept in place to continue its filtering job. Essentially, the first and second filters are in communication with the first and second independent evaporator coils, respectively, for independently preventing impurities from entering into the first and second independent evaporator coils.

[0034] Shutoff valves **152** and **154** can be placed between the filter and the inflow of the refrigerant line in order to provide a means by which the flow of refrigerant can be manually stopped in case of a need for repair or other such situation. The shut off valve is

basically a service access valve, used in case of a problem. The provision of these separate shutoff valves provides the ability to service one evaporator coil in the evaporator while the other evaporator coil can remain operational, thereby still cooling the display case. Essentially, the first and second shutoff valves are in communication with the first and second independent evaporator coils, respectively, for manually stopping refrigerant flow to the first and second independent evaporator coils. Of course, if no filter is provided, each shutoff valve is placed between the inflow of the refrigerant line and the solenoid.

[0035] A flow regulating device, such as a thermostatic expansion valve **156** and **158**, or TEV or TX valve, can be provided between each solenoid and evaporator coil. The TX valves regulate refrigerant flow into the evaporator. The flow regulating device is generally an expansion device if a liquid is used, but can alternatively be any other type of flow regulating device. The TX valve, or expansion valve, controls the rate of refrigerant passed into the system. It can be modulated depending on situational demand (i.e. measured value compared to desired value). Essentially, the first and second flow regulating devices are in communication with the first and second independent evaporator coils, respectively, for regulating refrigerant flow to the first and second independent evaporator coils.

[0036] A 1-to-2 distributor can also provided between the flow regulating device and the evaporator coil, for equally distributing refrigerant flow from the flow regulating device into each circuit, or portion, of the evaporator coil. In this example, each distributor **160**, **162** splits the refrigerant line into two lines, for feeding an inlet **134**, **136**, respectively. Each distributor can be connected to the outlet of a TEV, with the outlet of the distributor preferably being machined to accept tubing which connects the distributor to each evaporator coil circuit. Essentially, the first and second distributors are in communication with the first and second independent evaporator coils, respectively, for equally distributing refrigerant flow to the first and second independent evaporator coils. Expansion devices and distributors are available for different applications and specifications, such as from the Sporlan Valve Company of Washington, Missouri.

[0037] Embodiments of the present invention can be used together in an advantageous manner. A plurality of evaporators according to an embodiment of the present invention can be connected to each other in parallel. This is advantageous, for example, in a grocery store where a plurality of refrigerated display cases are placed adjacent each other.

Each of these evaporators has a first and second independently-controlled evaporator coil. However, when the evaporators are connected in parallel, the first evaporator coils of each evaporator are connected together. Similarly, the second evaporator coil of each evaporator are connected together. The plurality of evaporators are controlled by a single pair of flow control valves, such as solenoid valves, i.e. a first solenoid valve and a second solenoid valve. This advantageously allows a plurality of evaporators according to an embodiment of the present invention, and therefore a plurality of refrigerated counters in which they can be placed, to be centrally controlled by a single pair of solenoid valves. This is advantageous as compared to currently known systems, in which a separate solenoid is required for each evaporator, or refrigerated display case. Therefore, savings in both cost and complexity are realized according to embodiments of the present invention.

[0038] In other words, according to an embodiment of the present invention, a cooling system is provided for use in a plurality of refrigerated display cases each having a display length. The cooling system includes a plurality of evaporators connected in parallel. Each evaporator has first and second independent evaporator coils co-extensive along the display length, with each evaporator coil being operable in a cooling cycle and a defrost cycle in alternating time periods in such a manner as to maintain a substantially constant cooling temperature throughout the refrigerated display case, even during a defrost cycle. The first evaporator coils of each of the plurality of evaporators are connected to one another and define a set of first evaporator coils. The second evaporator coils of each of the plurality of evaporators are connected to one another and define a set of second evaporator coils. First and second flow control valves are provided, in communication with the sets of first and second evaporator coils, respectively, for independently controlling refrigerant flow to the sets of first and second sets of evaporator coils. The cooling system can also include a common return connected to the sets of first and second evaporator coils for receiving ambient air to be cooled by the evaporator, but this is only a preferred feature.

[0039] In the cooling system described above, the display length of each refrigerated display case need not be the same. If the display cases have a different display length, then the independent evaporator coils for each refrigerated display case will be co-extensive along the display length for that particular refrigerated display case.

[0040] Although not illustrated in **Fig. 6**, a cooling system according to an embodiment of the present invention preferably includes a controller, such as a time clock, timing system, or other such device. The controller is in communication with the solenoid valves **146** and **148** for scheduling and controlling the alternating defrosting of the evaporator coils. Note that alternatively, the solenoid valves, or flow control valves, can be manually controlled. The controller is preferably used to implement a defrosting method in four stages, as follows.

[0041] Stage 1: When the controller initiates a defrost, the solenoid valve **146** closes, thereby inhibiting any refrigerant from circulating in the evaporator coil **130**. Solenoid **148** stays open and the fans still operate. The evaporator coil **132** will be defrosting while the evaporator coil **130** still refrigerates. Keep in mind that the evaporator coil **130** substantially covers the entire length of a display case of the refrigeration system, and therefore the display area of the display case remains uniformly cooled even during the defrosting of the evaporator coil **132**.

[0042] Stage 2: At the conclusion of stage 1 of the defrost cycle, solenoid valve **146** will reopen. At that time, both of the evaporator coils **130** and **132** are in a refrigerating mode.

[0043] Stage 3: After a predetermined amount of time, e.g. two hours after the initiation of stage 1, the controller initiates a second defrost. At that time, solenoid valve **148** will close and no more refrigerant will circulate in the evaporator coil **132**. Solenoid **146** stays open and the fans still operate. The evaporator coil **132** will be defrosting while the evaporator coil **130** still refrigerates. Keep in mind that the evaporator coil **130** substantially covers the entire length of a display case of the refrigeration system, and therefore the display area of the display case remains uniformly cooled even during the defrosting of the evaporator coil **132**.

[0044] Stage 4: At the conclusion of stage 3 of the defrost cycle, solenoid valve **148** will reopen. At that time, both of the evaporator coils **130** and **132** are in a refrigerating mode.

[0045] The cycle of stages 1-4 preferably continues over a twenty-four hour period. The actual amount of time spent defrosting each evaporator coil and spent with both

evaporator coils in the refrigerating mode can be varied. Although there is no need to perform the defrosting steps in off-peak times, this can be done if desired.

[0046] Although there are some known methods in which coils are alternatingly defrosted, this is known only in the context of alternatingly defrosting separate evaporators in a series evaporators placed adjacent one another. There is no known method in which evaporator coils in the same evaporator are alternatingly cooled and defrosted. Moreover, in the known methods, there is no provision for at least one of the evaporator coils covering the entire surface area to be cooled in order to maintain a substantially constant cooling temperature, even during defrosting of one of the evaporator coils.

[0047] The cooling system can optionally include a temperature/pressure regulator for regulating the temperature and/or pressure in the cooling system. The cooling system can further optionally include a data recording unit, which records temperature readings of the display case on a computer or any other means. The data recording unit can automatically alert an operator when the temperature goes below a defined threshold.

[0048] Embodiments of the present invention can be used in both open refrigerated display cases, as well as closed refrigerated display cases. Also, the refrigerant used can be a liquid or a gas, such as freon or glycol.

[0049] The above-described embodiments of the present invention are intended to be examples only. Alterations, modifications and variations may be effected to the particular embodiments by those of skill in the art without departing from the scope of the invention, which is defined solely by the claims appended hereto.